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(56) Documents Cited
EP 0333228 A2 EP 0321237 A2 EP 0303528 A1
US 2862251 A

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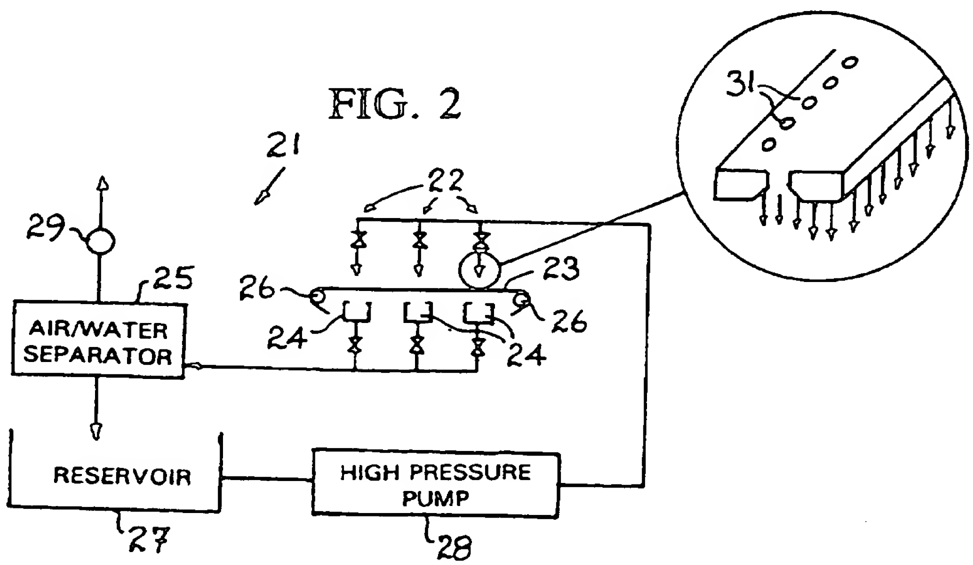
(54) **A nonwoven cellulose fabric**

(57) A hydroentangled nonwoven fabric comprising entangled manmade cellulose fibres such as lyocell or viscose bonded together by their entanglement, the fabric having a tenacity when the fabric is wet which is greater than when the fabric is dry. The invention also relates to a method of manufacturing such a fabric in which a web of regenerated staple cellulose fibres on a conveyor (23) is passed under high pressure water jets (22).

FIG. 2



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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

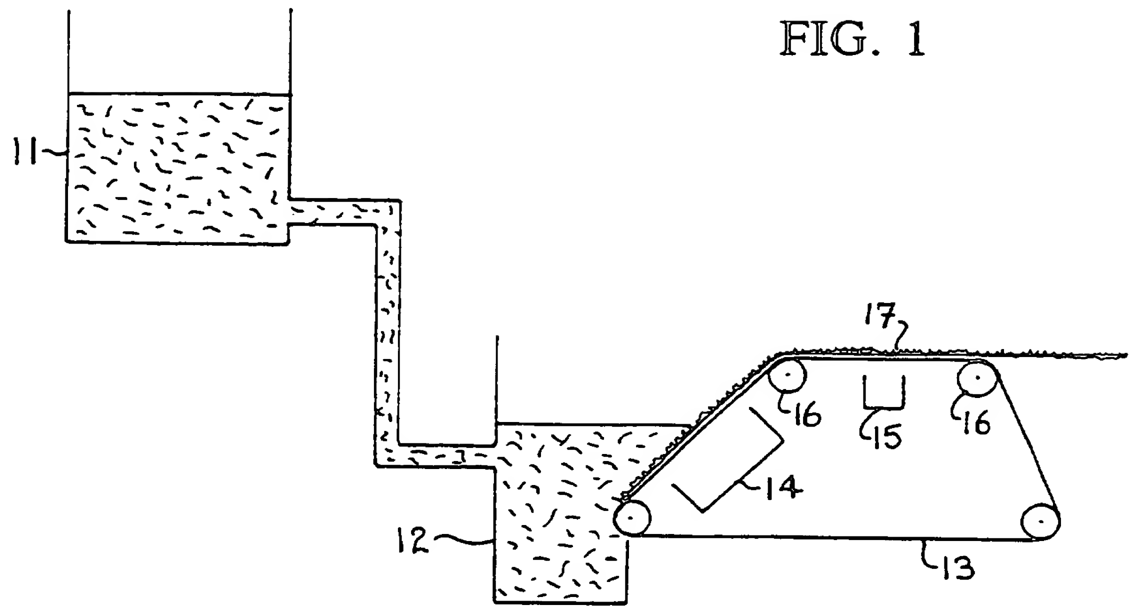
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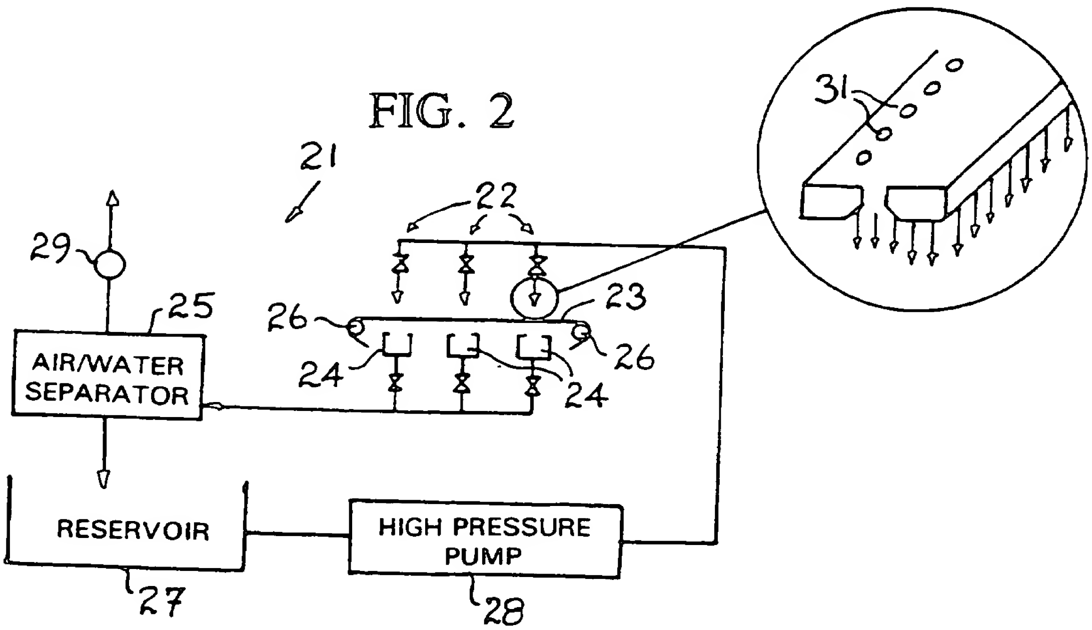
FIG. 1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AIR/WATER SEPARATOR
RESERVOIR
HIGH PRESSURE PUMP

FIG. 2

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A Nonwoven Fabric

This invention relates to a hydroentangled nonwoven fabric and to a method of manufacturing such a fabric.

Nonwoven fabrics made by subjecting a web of discontinuous fibres to the action of high pressure water jets are known and typical hydroentanglement techniques are described in US-A-3,485,706 and US-A-3,508,308.

Known nonwoven fabrics produced by the hydroentanglement process generally have an adequate dry strength for their intended end use. However the strength of such fabrics tends to fall away when the fabrics become wet. The problem relating to the wet strength of nonwoven fabrics, particularly those based on cellulose, has conventionally been solved by the use of resin binders to promote inter fibre bonding. Nonwoven fabrics are typically bonded by acrylic latexes, or thermally bonded by adding a thermally bonded fibre, e.g. polypropylene.

For certain nonwoven fabric products, in particular products such as paper towels, protective garments or medical or surgical materials having medical applications or requiring good absorbency, the presence of additional binders to improve the wet strength of the fabric may be undesirable since it could affect the medical and absorbency characteristics of the material.

An aim of the present invention is to provide a nonwoven fabric having an improved wet strength.

According to one aspect of the present invention there is provided a hydroentangled nonwoven fabric comprising entangled man-made cellulose fibres bound together solely by their entanglement, the fabric having a tenacity when wet which is greater than its tenacity when dry.

The relative wet and dry strengths of a fabric according to the invention is contrary to the relative wet and dry strengths of the cellulose fibres from which the fabric is made. In particular, known man-made cellulose fibres, such as rayon, lyocell and viscose fibres, typically have a tensile strength which is lower when wet than when dry.

Preferably the fibres are staple fibres having a length of between 5 and 6 mm. If the fibres are formed from lyocell, that is cellulose reconstituted from a solution of cellulose in amine oxide, the fibres will preferably have a decitex of between 0.1 and 1.7 decitex.

If the fibres are formed by the viscose process, the preferred decitex of the fibres does not exceed 4.0 decitex, and preferably lies between 1.6 and 4.0 decitex.

According to another aspect of the present invention, a method of manufacturing a fabric according to said one

aspect comprises passing a web of regenerated cellulose staple fibres, preferably each having a length of from 5 to 6 mm, on a belt under at least one high pressure water jet assembly arranged transversely of the belt, the or at least one of the water jet assemblies have an operating pressure of between 75 and 200 bar.

Preferably at least the final jet assembly has an operating pressure of about 100 bar.

The web of reconstituted cellulose fibre is prepared by a wet lay process and has an aereal density of from 50 to 200 gm^{-2} and preferably of from 60 to 80 gm^{-2}.

An embodiment of the invention will now be described, by way of example only, with particular reference to the accompanying drawing, in which:-

Figure 1 is a schematic diagram of an apparatus for forming a wet-laid web of fibres which can subsequently be hydroentangled to form a nonwoven fabric according to the present invention; and

Figure 2 is a schematic diagram of a hydroentanglement apparatus of the type used to form a nonwoven fabric according to the present invention.

Figure 1 shows in schematic form a Pilot Scale Neue Breuderhaus inclined wire wet lay system for forming a wet-laid web of fibres. In a first stage, the wet-laid web is manufactured by dispersing short cut or staple fibres in water to form a strong slurry in tank 11. The slurry is fed into a reservoir 12 where it is deposited onto an endless mesh conveyor belt 13 which passes around guide rollers 16 and interfaces with a portion of the reservoir 12. Water is removed by vacuum boxes 14 and 15 which suck water through the belt 13 to leave a web 17 of deposited fibres on the belt 13.

The web 17 is then either rolled onto a storage roller for further treatment at a different site or at a different time, or fed directly into an apparatus for manufacture of a nonwoven fabric.

In the second stage of the process, the wet-laid web 17 is fed into the hydroentanglement apparatus 21 shown schematically in Figure 2. The apparatus 21 comprises a porous mesh endless conveyor belt 23 passing around guide rollers 26. The belt has a mesh size of 100 mesh and a width of about 30 cm. Three sets of jet head assemblies 22 are spaced along the horizontal portion of the conveyor belt 23 at intervals of from 20 to 25 cm and extend transversely thereto.

Vacuum boxes 24 are arranged beneath the horizontal portion

of the conveyor belt 23 in alignment with the jet head assemblies 22 to remove water from the conveyor through the mesh belt. The water is removed from the conveyor 23 by a vacuum pump 29 acting through an air/water separator 25 which passes the recovered water to a reservoir 27. The recovered water is fed from the reservoir 27 back to the jet head assemblies 22 via a high pressure pump 28.

The jets 31 of the jet head assemblies 22 are arranged 12.5 mm above the conveyor belt 23. The jets 31 are 120 microns in diameter and are arranged as a single row of holes extending across the conveyor, the holes being spaced at a hole density of 40 holes per inch wide (16 holes per cm).

The entangled web 17 from the first stage is put onto the conveyor belt 23 and passes under the jet assemblies 22 at a speed of between 2 and 7 m per minute. Water is jetted out of two neighbouring assemblies of the three jet assemblies 22. The web 17 makes four passes through the hydro-entanglement machine, with one side of the web being exposed to the jets on passes 1 and 3 and the other side being exposed to the jets on passes 2 and 4.

Different fabric test samples were prepared to illustrate the invention. In all cases, in the first stage of the process, 75 g of dry weight fibres were dispersed in 300 l of water to give a 0.25% consistency suspension which was then agitated for 4½ minutes. The dispersed suspension was

laid onto the endless belt, moving at a speed of 0.35 ms^{-1} to lay a web of approximately 80 gm^{-2}. In the second stage of the process, the jet head pressures and conveyor speeds for manufacturing the different test samples were as follows:-

Sample 1

	Jet 1	Jet 2	Conveyor Speed
Pass 1	40 bar	40 bar	2.5 m/min
Pass 2	40 bar	50 bar	6.5 m/min
Pass 3	50 bar	50 bar	6.5 m/min
Pass 4	50 bar	50 bar	2.5 m/min

Sample 2

	Jet 1	Jet 2	Conveyor Speed
Pass 1	40 bar	40 bar	2.5 m/min
Pass 2	40 bar	60 bar	6.5 m/min
Pass 3	60 bar	60 bar	6.5 m/min
Pass 4	60 bar	75 bar	2.5 m/min

Samples 3-6

	Jet 1	Jet 2	Conveyor Speed
Pass 1	40 bar	40 bar	2.5 m/min
Pass 2	60 bar	60 bar	6.5 m/min
Pass 3	80 bar	80 bar	6.5 m/min
Pass 4	100 bar	100 bar	2.5 m/min

Fibre Tenacity

The tenacities of the fibres used in the tests were as follows:-

	Dry Tenacity	Wet Tenacity
Lyocell 1.7 dtex	41.8 cN/tex	33.5 cN/tex
Lyocell 1.4 dtex	45 cN/tex	37.9 cN/tex
Viscose 1.7 dtex	22 cN/tex	12 cN/tex

It can be seen that for each fibre the wet strength is lower than the dry strength.

Tests

The hydroentangled fabrics manufactured from various staple fibres were tested for wet and dry tensile properties in the machine direction (MD) and cross direction (CD) according to BSEN 29073-3 (1992). The results are presented so that the dry results have a rating of 100, and the wet results have a relative rating. The samples referred to below are for different machine runs.

Generally, although all the results have been standardised to emphasise the changes in tensile properties between wet and dry fabrics, the fabric wet and dry strengths increase with increasing hydroentanglement maximum pressures (pass 4) between 50 and 100 bar and the fabric strength increases with increasing staple fibre lengths from 5 mm up to 12 mm. For a given length of fibre, e.g. 5 mm, a decrease in decitex of the fibre say from 1.7 to 1.4, is generally accompanied by an increase in fabric strength.

Sample 1

Fibre Type	Tenacity MD Dry	Tenacity MD Wet	Tenacity CD Dry	Tenacity CD Wet
1.7 d.tex lyocell 5mm	100	71	100	93
1.4 d.tex lyocell 5mm	100	85	100	83
1.7 d.tex viscose 5mm	100	130	100	51

Sample 2

Fibre Type	Tenacity MD Dry	Tenacity MD Wet	Tenacity CD Dry	Tenacity CD Wet
1.7 d.tex lyocell 5mm	100	82	100	81
1.4 d.tex lyocell 5mm	100	104	100	77
1.7 d.tex viscose 5mm	100	181	100	240

Sample 3

Fibre Type	Tenacity MD Dry	Tenacity MD Wet	Tenacity CD Dry	Tenacity CD Wet
1.7 d.tex lyocell 5mm	100	105	100	104
1.4 d.tex lyocell 5mm	100	157	100	152
1.7 d.tex viscose 5mm	100	104	100	135

Sample 4

Fibre Type	Tenacity MD Dry	Tenacity MD Wet	Tenacity CD Dry	Tenacity CD Wet
1.7 d.tex lyocell 5mm	100	103	100	87
1.4 d.tex lyocell 5mm	100	130	100	128
1.7 d.tex viscose 5mm	100	103	100	87
1.7 d.tex lyocell 8mm	100	73	100	70
1.7 d.tex lyocell 10mm	100	58	100	63
1.7 d.tex lyocell 12mm	100	59	100	80

Sample 5

Fibre Type	Tenacity MD Dry	MD Wet	CD Dry	CD Wet
1.7 d.tex lyocell 5mm	100	72	100	116
1.4 d.tex lyocell 5mm	100	120	100	119
1.7 d.tex viscose 5mm	100	72	100	84

Sample 6

Fibre Type (all viscose fibres)	Overall Tenacity Dry	Wet
0.75 d.tex 4mm	100	67%
0.95 d.tex 4mm	100	96%
0.95 d.tex 6mm	100	56%
0.95 d.tex 8mm	100	52%
1.7 d.tex 5mm	100	170%
3.3 d.tex 6mm	100	128%
trilobal 12mm(2.6 d.tex)	100	74%

Overall tenacity is given by $\sqrt{\frac{(MD^2+CD^2)}{2}}$

It can be seen that the fibres in themselves have a lower wet strength than dry strength and this observed property is generally reflected in the comparative strength of nonwoven fabric prepared from these fibres.

It is, therefore, surprising that it is possible to produce a nonwoven hydroentangled fabric which has a greater wet

strength than dry strength without the use of resin binders.

From the samples and test results it can be seen that hydroentangled fabric made from lyocell staple fibre having a decitex below 1.7 d.tex, and preferably 1.4 d.tex, has a generally higher wet strength than dry strength. This is true for all fabrics made according to the Samples 3-5.

It can be seen from Sample 4 that the increase in staple fibre length is accompanied by a general fall off in wet strength of the fabric as compared with its dry strength. This is also confirmed for viscose staple fibres as shown in Sample 6. An optimum staple fibre length is about 5 to 6 mm. It can also be seen from the results that viscose fibres having a decitex of about 1.7 and upwards to about 4.0 d.tex also show an increase in wet strength.

Claims

1. A hydroentangled nonwoven fabric comprising entangled man-made cellulose fibres bonded together solely by their entanglement, the fabric having a tenacity when wet which is greater than its tenacity when dry.

2. A fabric according to claim 1, wherein the fibres are staple fibres having a length of from 5 to 6 mm.

3. A fabric according to claim 1 or 2, wherein the fibres are non-fibrillated lyocell.

4. A fabric according to claim 3, wherein the fibres have a decitex of between 0.1 and 1.7.

5. A fabric according to claim 1 or 2, wherein the fibre comprises viscose fibres.

6. A fabric according to claim 5, wherein the viscose fibre has a decitex not exceeding 4.0 decitex.

7. A fabric according to any one of the preceding claims, wherein the fabric has an aereal density of from 50 to 200 gm^{-2}.

8. A method of manufacturing a fabric according to any one of claims 1 to 7, wherein a web of regenerated cellulose

staple fibres, each having a length of between 5 and 6 mm is passed on a belt under at least one high pressure water jet assembly arranged transversely of the belt, and the at least one of the jet assemblies has an operating pressure of between 75 and 200 bar.

9. A method according to claim 8, wherein at least the final jet assembly has an operating pressure of 100 bar.

10. A method according to claim 8 or 9, wherein the web of regenerated cellulose fibres is a wet laid web having an aereal density of between 50 and 200 gm^{-2}.

The Patent Office

13

Application No: GB 9601725.6
Claims searched: 1-10

Examiner: Alexander Littlejohn
Date of search: 7 March 1996

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): D1R (RFH, RFZ, RGH, RGZ)

Int Cl (Ed.6): D04H 1/44, 1/46

Other: Online: WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
Y	EP0333228A2	(Kimberly-Clark) see e.g. page 4 line 39 and page 15 line 32	8,9,10
X,Y	EP0321237A2	(Asahi Kasei) see whole document, especially page 2 line 58 and Example 3 on pages 9,10	X:1-7 Y:8-10
X,Y	EP0303528A1	(James River) see whole document, e.g. page 3 lines 7-12 and page 4 lines 22-25	X:1,3,4,5,6,7 Y:8,9,10
X,Y	US2862251	(Kalwaites) see whole document, e.g. column 4 lines 63-70 and column 19 lines 68-73	X:1-7 Y:8-10

X Document indicating lack of novelty or inventive step
Y Document indicating lack of inventive step if combined with one or more other documents of same category.
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